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alberta pork production handbook

Alberta
AGRICULTURE
Pork Industry Branch



Agdex 440/41-2
August 1990

ESTIMATED BREEDING VALUES: A TOOL FOR GENETIC IMPROVEMENT OF SWINE

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animal's performance depending on the trait. The key to genetic improvement of livestock is to distinguish between genetic and environmental factors that influence performance and to select only those animals which are genetically superior. Performance that is the result of good management will not be passed on to the next generation, whereas performance due to genetic superiority will be repeated.

Table 1. Estimates of heritability for economically important traits in swine

Trait	Heritability (%)
Productive Traits	
Pig Weight @ 5 - 6 months	20 - 25
Average Daily Gain (weaning - 90 kg)	25 - 30
Feed Efficiency	25 - 30
Reproductive Traits	
Number of Pigs Farrowed	5 - 10
Number of Pigs Weaned	5 - 10
Litter Weight & Weaning	15 - 20
Structural Traits	
Length of Body	50 - 60
Length of Legs	50 - 60
Number of Nipples	30 - 40
Length of Carcass	50 - 60
Backfat Thickness	40 - 50
Thickness of Belly	40 - 50

Adapted from: J. Lasley 1978 *Genetics of Livestock Improvement*.

A. Introduction

The performance of an animal is determined primarily by two factors — genetics and environment, which includes management. Often environment can affect an animal's performance as much or more so than the animal's genetic make-up. Table 1 shows the amount of genetics (per cent heritability) involved in various traits. Environment makes up the remaining 40 to 90 per cent of an

B. Performance testing of swine

Supervised performance testing of swine began in 1967 with the development of the Record of Performance (ROP) Swine Testing Program. Its purpose was to help pork producers to identify and select superior replacement breeding stock.

Through the ROP Program, breeders were provided with performance test information on pigs tested either on the home farm or at a central test station (expressed as mm of fat at 90 or 100 kg and days from birth to 90 or 100 kg). Central station testing has provided performance comparisons of young boars from a number of different herds. All boars are tested under similar environmental and management conditions; therefore, differences in performance can be attributed to genetics rather than herd management. The central test station also gives an indication of the genetic merit of a herd relative to other herds using the same test station. The number of boars that can be tested each year, however, is limited to approximately 1,000 in Alberta.

The home test component allowed for performance testing of larger numbers of young boars and gilts. Home test evaluations were of limited value because comparisons of breeding stock were valid only within the herd in which the pigs were raised. The backfat and growth rate measurements were only valid within the herd because evaluations for each pig were expressed relative to the average performance of all pigs in the herd. Herds can differ greatly in genetic merit and management (environmental) conditions, so comparisons on the basis of backfat and growth rate could not be made between herds.

Performance test information generated either on the farm or at the test station was based strictly on the pigs own performance. It did not take into account information on related animals, which is useful in determining the genetic merit of a pig when it is combined with the pigs own performance data. Because related animals are similar in their genetic make-up, their test results can also be used to predict an animal's genetic worth.

C. The Canadian swine genetic evaluation program

To overcome the limitations of the ROP system, the Canadian Swine Genetic Evaluation Program was developed in 1985. It provides pork producers with estimated breeding values (EBVs) for backfat thickness and days from birth to 100 kg for performance tested pigs. EBVs are estimates of the genetic (breeding) values of an animal for a particular trait.

D. Estimated breeding values

Estimated breeding values are simply an extension of the ROP Program. Data is collected in the same way; however, the analysis of the data is quite

different. EBVs take into account the following factors:

- The heritability of the trait, or that part of a trait that is expected to be inherited;
- The amount of information available on each boar or sow — i.e. number of relatives as well as number of progeny, number of litters, and number of herds;
- The genetic merit of the herd in which the pig was raised; and
- The genetic trend (change) in the breed over time for all tested pigs on the program in the same region (Western Canada).

EBVs take into account performance information (backfat and days to 100 kg) of the individual, as well as all related animals (sire, dam, litter mates, etc.) and progeny if and when their test information becomes available. The more information that is available on related animals, the greater the accuracy of the EBV. This is referred to as 'repeatability'. Theoretically, repeatability values can range from 0 to 100% but in practice published values on sires and dams will range between 40 to 99 per cent. The higher the repeatability value, the more accurate is its EBV. For example, AI sires with many progeny will have repeatability values approaching 99 per cent. As performance information becomes available on progeny, the relative importance of the animal's own record, as well as records on its other relatives diminishes because the performance that the selected animal has passed on to its progeny becomes the most important factor.

EBVs also account for the effect of management on an animal's performance. This is achieved through the use of 'genetic links' between herds. Genetic links are created through the use of artificial insemination, the central test station and the sale of breeding stock from one herd to another. Through these methods, animals of a related genetic background are raised in different herds and thus herds become "linked". Because EBVs account separately for the effects of environment and genetics, the management effect can be removed, allowing valid comparisons of breeding stock in different herds. This means that an individual pig can be compared genetically to all other tested pigs of the same breed.

E. Breeder reports

The Canadian Swine Genetic Evaluation Program provides producers enrolled on the program with two valuable reports:

- Sire and dam report
- Herd activity monitor

Sire and dam report

A separate sire and dam report is produced for each breed (Yorkshire, Landrace, Hampshire, Duroc, Lacombe) and region (Maritimes, Quebec, Ontario, Western). To be listed in the report a boar or sow must meet the following criteria:

- The animal must have a complete identification, including herd letters, pig number and year letter according to Canadian Livestock Records Corporation (CLRC); and
- Must have at least one progeny and a reliability on the EBV index of at least 45%.

The report lists animal's identification, EBVs for backfat thickness and days to 100 kg, as well as an index combining EBVs for backfat and days and its repeatability. The report also lists for each breeding animal the number of progeny tested, the number of litters and the number of herds (including the test station) in which progeny were tested. The last herd in which the sire or dam had progeny is also indicated. EBVs are expressed relative to the average of all pigs of the same breed born and tested in herds within the last two years. Because the goal is to reduce backfat and days to 100 kg, sires and dams with negative EBVs are breed improvers. Their use will result in a decrease in backfat and/or days. The EBV index is useful for breeders who wish to select for growth rate and backfat thickness at the same time. The traits are weighted so that a change of 1 mm in backfat has approximately the same value as a change of 4 days in growth rate. The average index for each breed is 100. For improvement in backfat and/or growth rate, progeny of sires and dams with indexes over 100 should be selected.

Sire and dam reports are published quarterly and are provided to producers enrolled on the Swine Improvement program. Copies can be obtained from: pork industry branch of Alberta Agriculture, Edmonton, phone (403) 427-5319.

Herd activity monitor

The Herd activity monitor (HAM) is a confidential report provided to each breeder on a quarterly basis. This report allows the breeder to assess genetic and management progress in the herd. The report lists the number of pigs tested in the last two years as well as the average EBV of pigs tested during this time period (compared to all other herds in the region). The report also gives a measure of environ-

mental or management performance of the herd, both in absolute terms and relative to the average herd. Trends in genetic and management performance over time are also given based on six-month periods. These trends can be used as an indicator of the effectiveness of a breeding program, provided that reasonable numbers of pigs are tested in each six-month period. The trends are also useful for determining the results of a change in management.

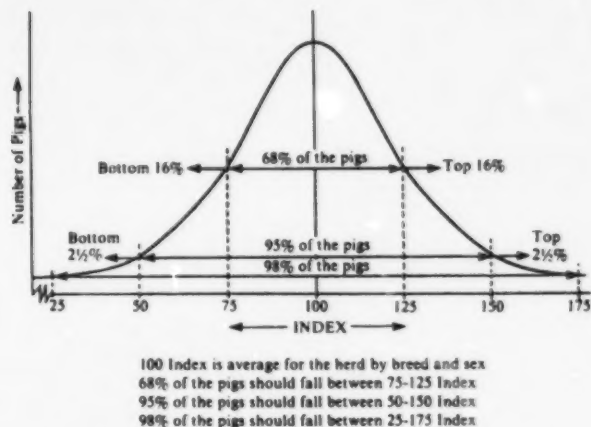


Figure 1. Index distribution curve.

F. Public reports

Each young boar and sow now tested on participating breeders farms has its EBVs calculated immediately by computer. The same thing is done as soon as boars complete test at the Leduc and Lacombe test stations. This information is available to commercial producers to assist them to select superior breeding stock. The farm test data is published in the monthly Provincial probe report (Figure 2) and the test station data is in the advance sale notice (Figure 3) which is printed two weeks before each test station sale.

Provincial probe report

The report is divided into two parts — boars and gilts. Complete information is listed for each boar tested. This report lists the following data for boars:

- Breeder's name and address - where the pigs where tested.
- 12 month average - the number of pigs of this breed and sex tested on this farm in the past 12 months and their average performance, useful

**Agriculture Canada
Alberta Agriculture
Provincial Probe Report**

B C A R S - Period: 01 JUN 1990 to 30 JUN 1990 - Index: (All)

Breeder Name and Address	Sire Identification A.I.	Dam Identification	Pig Breed Identification	Sex	Adj. Fat	Adj. Age	EBV Fat	EBV Age	Repeata- bility	EBV Index
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HAMPSHIRE

FIVE LAKES FMS. 08*0003

MAYERTHORPE	403-786-2187	12 month average	140 pigs		12.6	202	-0.1	2.8		94
AHKP 504X	JKAA 3204X	H	JKAA 402Z	M	11.5	175	-0.5	0.1	51	116
AHKP 504X	JKAA 608Y	H	JKAA27401Y	M	8.6	222	-1.8	9.4	50	128
AHKP 504X	JKAA 2804Y	H	JKAA27602Y	M	7.9	214	-2.1	7.1	49	143
AHKP 504X	YAP 2610U	H	YAP 28306Y	M	9.7	189	-1.6	4.8	56	135
YAP 1300SW	NP 13110W	H	NP 26101Y	M	11.9	211	-0.5	9.6	56	84
YAP 1300SW	NP 13110W	H	NP 26102Y	M	9.1	222	-1.4	14.1	56	98
YAP 1300SW	NP 13110W	H	NP 26104Y	M	9.4	209	-1.3	8.5	56	114

BROWNLEE, JIM 08*0318

HAIRY HILL	403-768-2313	12 month average	47 pigs		12.8	202	0.0	0.6		99
ANZI 512W	AHKP 376U	H	AHKP 723Y	M	11.8	180	0.2	0.3	54	93
ANZI 512W	AHKP 376U	H	AHKP 725Y	M	10.4	177	-0.3	-1.3	54	113
ADVI 10W	AHKP 170U	H	AHKP 11Z	M	11.5	176	-1.5	-2.9	57	155
ADVI 10W	AHKP 407U	H	AHKP 708Y	M	11.9	176	-0.7	-1.4	59	128

G I L T S - Period: 01 JUN 1990 to 30 JUN 1990 - Index: (All)

Breeder Name and Address	Sire Identification A.I.	Dam Identification	Pig Breed Identification	Sex	Adj. Fat	Adj. Age	EBV Fat	EBV Age	Repeata- bility	EBV Index
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COMMERCIAL

NORTHBRIDGE ENT. 08*0015		Period average	43 pigs		13.7	166			40	(101)
ONOWAY	403-967-5723	12 month average	452 pigs		15.9	156				(99)
MASCHWEYER, DOUG & GERALD 08*0077		Period average	3 pigs		14.4	133			40	(114)
BRUDERHEIM	403-998-2845	12 month average	0 pigs		0.0	0				()

LANDRACE

DUFF, DONALD 08*0456		Period average	22 pigs		15.7	161	0.0	-2.9	54	111
FT SASKATCHEWAN	403-998-3101	12 month average	162 pigs		15.8	157	0.0	-2.3		107
HUVENARS, ADRIAN 08*0552		Period average	6 pigs		14.1	164	-0.3	-2.9	61	116
HAYS	403-725-2411	12 month average	48 pigs		15.9	168	-0.2	-0.7		107
LAKELAND COLLEG 08*1106		Period average	12 pigs		13.7	179	-0.5	1.9	55	101
VERMILION	403-853-8597	12 month average	146 pigs		13.7	174	-0.2	0.5		102

Figure 2. Sample page from a provincial probe report.

only as a guide to the herd size and numbers available for selection.

- Pig identification - the identity of the boar tested according to CLRC.
- Breed - the breed of the pig tested according to the following codes:

Y = purebred Yorkshire
GY = straightbred or grade Yorkshire
L = purebred Landrace
GL = straightbred or grade Landrace
C = purebred Lacombe
GC = straightbred or grade Lacombe
H = purebred Hampshire
GH = straightbred or grade Hampshire
D = purebred Duroc
GD = straightbred or grade Duroc
9 = Commercial (undetermined breed origin or crosses of the above).

Purebred - a pig that conforms to the breed type specified by the breed association and is eligible for registration in the herd book maintained by CLRC.

Straightbred or Grade - a pig that conforms to a certain breed type as determined by the owner and is not eligible for registration with CLRC.

- Sire of the pig tested.
- Dam of pig tested.
- Adjusted fat - the average of the four backfat measurements taken on the pig's back and adjusted to 100 kg (for an explanation of backfat measurement, see the factsheet *The Alberta Swine Improvement Program*, Agdex 440/41-7).
- Adjusted age - the adjusted number of days from birth to 100 kg
- EBV fat - the calculated breeding value for fat; zero is average for the breed; numbers below zero are desirable, the larger the negative number, the better.
- EBV age - the calculated breeding value for age, again zero is average and negative numbers mean that a particular boar grows faster than average.
- Repeatability % - the accuracy of the EBVs for fat and age expressed as a percentage; these will range between 40 and 60% depending on how much pedigree information is available.
- Index - the EBV for fat and the EBV for age are combined into one number and compared to the average for the breed which is 100; the index follows the distribution shown below; to be better than average, indexes should be over 100.

Gilts are not listed individually because there are too many tested. Only group averages are provided. The

number tested per month and per year in a breed on each seedstock farm on the program and their average performance.

Test station sale notice

It contains basically the same information as on the Provincial probe report. Boars are listed from highest index down to 100. Any animal with an index of less than 100 is culled. EBVs for fat and age, the repeatability and index are calculated similar to the farm test data, however there are a few variations as follows:

1. At the test station, the EBV for age is calculated on "gain on test". This is the actual daily gain for each boar between 30 and 90 kg. This is a more genetically precise figure to use (rather than days from birth to 100 kg). While a piglet is on the sow, its growth rate is largely determined by the sow, not its own genetics.
2. Age to 100 kg (days). This is provided for information only for the above reason, so it is not used in the EBV calculations.
3. Feed conversion per pen. This is the average feed conversion per pen. Boars are fed as littermate pairs. This then, it not an accurate figure for each boar. This is not used in any calculation, it is for information only.

Test station sale notices are printed two weeks before each sale. The sales are held the second Friday of every month at the Leduc or Lacombe test stations. Phone the pork industry branch in Edmonton at 427-5319 to get on the mailing list.

Using EBVs

The Canadian Swine Genetic Evaluation Program provides breeders and commercial producers with a means of identifying and selecting genetically superior breeding stock. Because EBVs account for the effect of management on an animal's performance, the selection of breeding stock is greatly simplified. Within a breed and region (e.g. Western Canada) comparisons can be made among all pigs in testing herds. Before the development and use of EBVs, accurate comparisons of breeding stock in different herds could not be made. The environment under which the animal was raised was not accounted for. Therefore an animal's performance could not be attributed strictly to genetics or management but some combination of the two factors. Genetic improvement results from the selection and use of genetically superior animals, not animals that have been raised under ideal management conditions. Table 2 compares two methods of selection of

**ADVANCE SALE NOTICE
PERFORMANCE TESTED BOARS
LACOMBE TEST STATION, PHONE 782-6360
FRIDAY, JULY 13, 1990 @ 1:30 PM**

The 20 boars catalogued here were selected on the basis of above-average performance and physical soundness from among 35 boars in the contemporary group which have completed test. All boars in the sale are from herds inspected under the Alberta Swine Herd Health Program and are guaranteed to be breeders.
NOTE: Boars are indexed 'within breed' therefore, do not compare indexes between breeds. Feed conversion and age are not in the index. Feed conversion is calculated as an average for the two or more boars per pen.
There are still 17 boars to complete test; 5 Yorkshire, 6 Landrace, 4 Lacombe, 2 Hampshire, 0 Duroc and 0 Crossbred. Phone the station for late results.
N.B. At the test station, the EBV for Age is based on Gain on Test.

(1) after sire's I.D. denotes semen from the Alberta A.I. Centre. (2) Ontario A.I. Association, and (4) Foreign

BREEDER'S NAME	BREED	SIRE'S TATTOO	BOAR'S TATTOO	BIRTH DATE	E.B.V. INDEX	FAT @ 100 KG (MM)	GAIN ON TEST (KG)	AVERAGE F.C. PER PEN	AGE ADJ TO 100 KG (DAYS)	EBV FAT (MM)	EBV AGE (DAYS)	REPEAT-ABILITY (%)
							(1)	(2)	(3)			
Acadia Breeders	York	ACA 21901X	ACA 2601Z	Feb 13	195	12.6	1.13	2.56	127	-1.8	-16.1	48
Acadia Breeders	York	ACA 21901X	ACA 2602Z	Feb 13	172	15.2	1.08	2.56	132	-0.9	-14.5	48
Eyeview Farm	York	RBM 709X	EYEV 37Z	Jan 22	150	10.0	1.11	2.28	136	-1.9	-4.0	49
Five Lakes Farms	Lac	JA 2050SM	JA 603Z	Jan 15	132	12.0	0.93	2.41	163	-1.9	2.5	48
Reiter Farms	York	KKEF 2021X	R1TR 1706Z	Jan 16	131	9.9	0.91	2.50	166	-2.3	2.8	45
Five Lakes Farms	Lac	JA 2050SM	JA 601Z	Jan 15	128	12.6	0.93	2.41	163	-1.7	2.5	48
Reiter Farms	York	KKEF 2091X	R1TR 3106Z	Feb 5	128	11.4	0.94	2.36	144	-1.0	-2.7	46
Eyeview Farm	York	RBM 709X	EYEV 38Z	Jan 22	126	12.5	1.05	2.28	139	-1.0	-2.1	49
Acadia Breeders	Land	USA 51X (4)	ACA 1501Z	Jan 16	126	12.2	1.03	2.44	147	-1.1	-2.0	54
Acadia Breeders	Land	USA 51X (4)	ACA 1502Z	Jan 16	121	12.0	0.94	2.44	161	-1.0	-1.2	54
Reiter Farms	Land	TONY 730X	R1TR 3605Z	Feb 7	120	11.5	0.90	2.52	144	-0.9	-1.5	63
Reiter Farms	Land	TONY 730X	R1TR 3606Z	Feb 7	114	13.7	1.00	2.52	139	0.3	-5.0	63
Five Lakes Farms	Hamp	JPVH 2180BX (1)	JKAA 1101Z	Jan 19	113	13.0	1.03	2.30	150	0.1	-5.0	54
Five Lakes Farms	Hamp	JPVH 2180BX (1)	JKAA 1103Z	Jan 19	113	12.6	1.00	2.30	156	0.0	-3.6	54
Bloomsbury Farm	Hamp	WN 1505W	WN 805Z	Jan 24	112	15.2	1.02	2.58	150	0.0	-3.7	57
Bloomsbury Farm	Lac	BL 1701Y	BL 1411Z	Feb 10	111	15.3	1.03	2.41	133	0.8	-8.3	49

Figure 3. Test station sale notice.

breeding stock — one using the traditional ROP index and the other, the EBV index.

Accurate selection of breeding stock is only the first step. Designing an effective breeding program is essential for the selection process to be of any benefit. EBVs can be used by breeders to predict the outcome of a specific mating. By simply averaging the EBVs of the parents the genetic merit of the progeny can be determined. An example is given in Figure 4.

Breeding programs must be evaluated on a regular basis in order to determine their effectiveness. Breeders can use the HAM to assess their breeding strategies. The HAM lists trends in genetic performance over time, indicating the amount of genetic improvement, or lack of it, in the breeders herd. Similar trends are given for management performance, allowing the breeder to determine the effectiveness of management practices in the herd.

The Canadian Swine Genetic Evaluation Program will also allow evaluation of current breeding practices and testing programs on a national level. Routine monitoring of genetic trends (genetic change) in

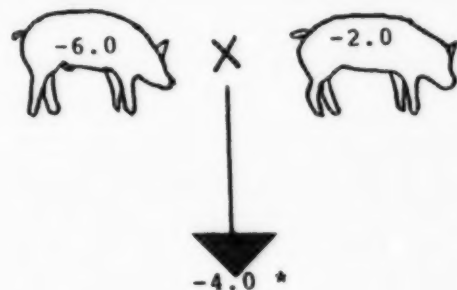


Figure 4. Genetic value of progeny from a specific mating.

*Genetic value of progeny from mating a boar with an EBV of -6.0 days and a sow with an EBV of -2.0 days. Not all progeny would have a genetic value of -4.0. However over a large number of matings the progeny would on average take 4 days less to reach 100 kg than progeny of parents with breed average.

Table 2: Two methods of comparing home-tested boars.

Example 1. Given only this information on home-tested boars:			
Boars	Measured backfat	Measured days to 100 kg	Phenotypic index
A	10.8 mm	131 days	139
B	12.5 mm	134 days	126
Which boar is likely superior?	If both boars are from the same herd, boar 'A' is superior.		
Why?	Because of lower backfat, fewer days to 100 kg and higher overall index in the same herd.		
	If both boars are from different herds, a fair comparison cannot be made.		
Why?	Given only this information it cannot be determined whether Boar A's apparent superiority is due to his genetic make-up or the management of the herd under which he was raised.		

Example 2. Given this information on the same boars:			
Boars	EBV backfat	EBV days to 100 kg	EBV index
A	-0.6 mm	+ 0.2 days	112
B	-2.0 mm	-3.5 days	149
Which boar is likely superior?	'B'		
Why?	Because of EBVs for backfat and days to 100 kg and a resulting higher EBV Index.		
Comments:	It can now be concluded that Boar A's apparent superiority in Example 1 was due to good management. Boar B is actually genetically superior, but poor management prevented him from showing his true potential. His genetic potential will be passed on to his progeny. Had Boar A been selected over Boar B on the basis of his performance figures as in Example 1, a genetic error would likely have been made.		

performance — tested breeding stock ensures continued genetic improvement for the entire industry.

Commercial producers have a powerful new tool to help them select breeding stock across many breeder herds in the region with the farm and test station EBV for young boars and gilts. However, EBV's are only one aspect of successfully selecting breeding stock. Health status and physical soundness are also very important. To combine all these aspects, see the following factsheets: *Sources of Breeding Stock*, Agdex 440/38-2; *Selection of the Herd Boar*, Agdex 443/10-1; *Establishing and Maintaining New Swine Herds*, Agdex 440/667-4; *The Alberta Swine Improvement Program*, Agdex 440/41-7.

Future developments

There are already developments to expand the EBV system. This includes a national EBV data base for backfat and growth rate. Then boars and gilts can be

selected from the same data base right across the country, not just within a region.

Sow productivity EBVs are also being developed. This is the other very important component to a profitable hog operation. It is explained in greater detail in the factsheet *The Alberta Swine Improvement Program*, Agdex 440/41-1. Definitions for technical terms used in this factsheet are also appended to 440/41-1.

Adapted from:

Ontario Ministry of Agriculture and Food factsheet.

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